Revisit Cloud Clearing vs. FOVs

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Oct. 11, 2007,

AIRS Science Team Meeting

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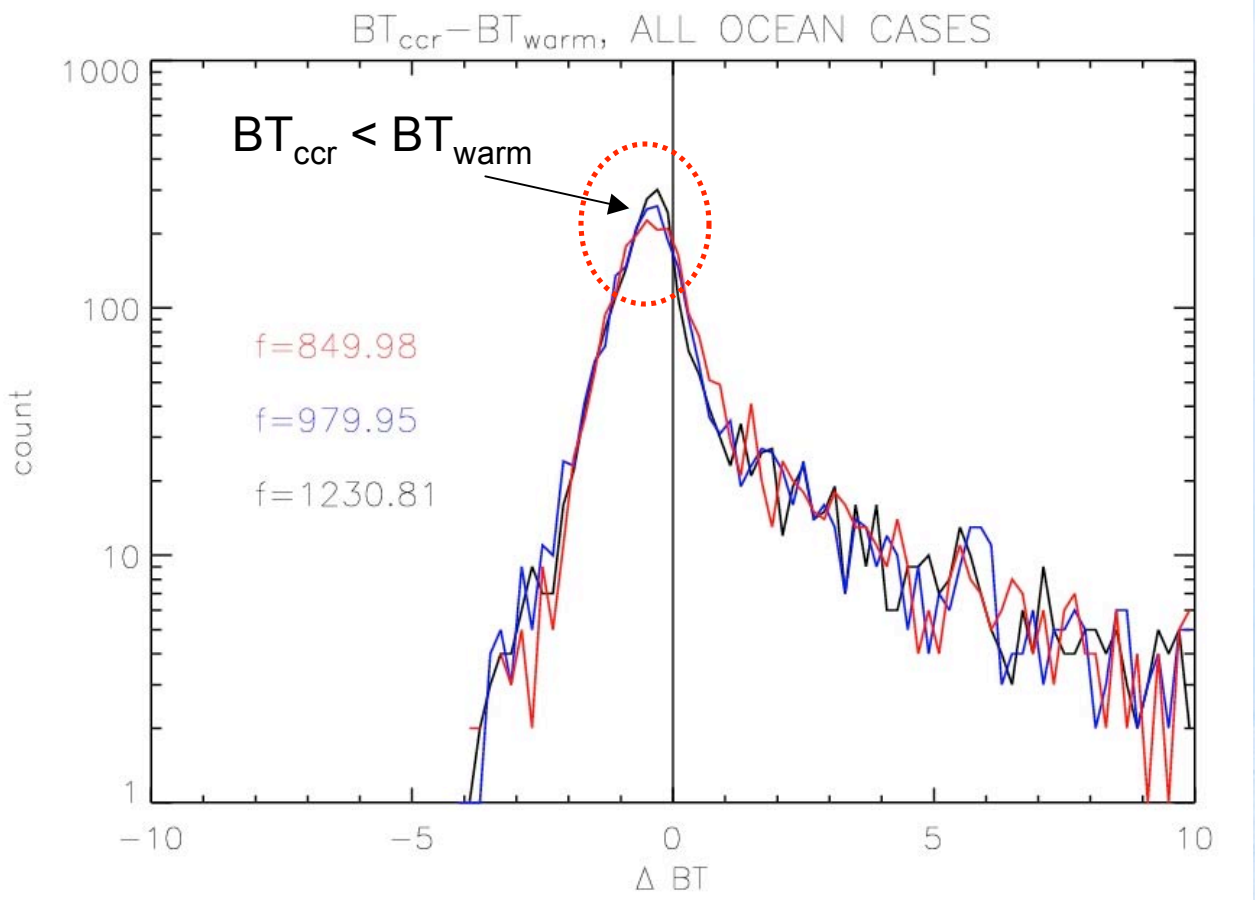
Overview

- Problem Statement
- Background/Preliminary Experiment
  - Test Case: Granule 401 Sep. 6, 2002
  - NOAA research code (emulate v.5), but did not apply v5 QA
- Results
- Summary/Recommendation for V6

Problem: Cold Bias in CCR?

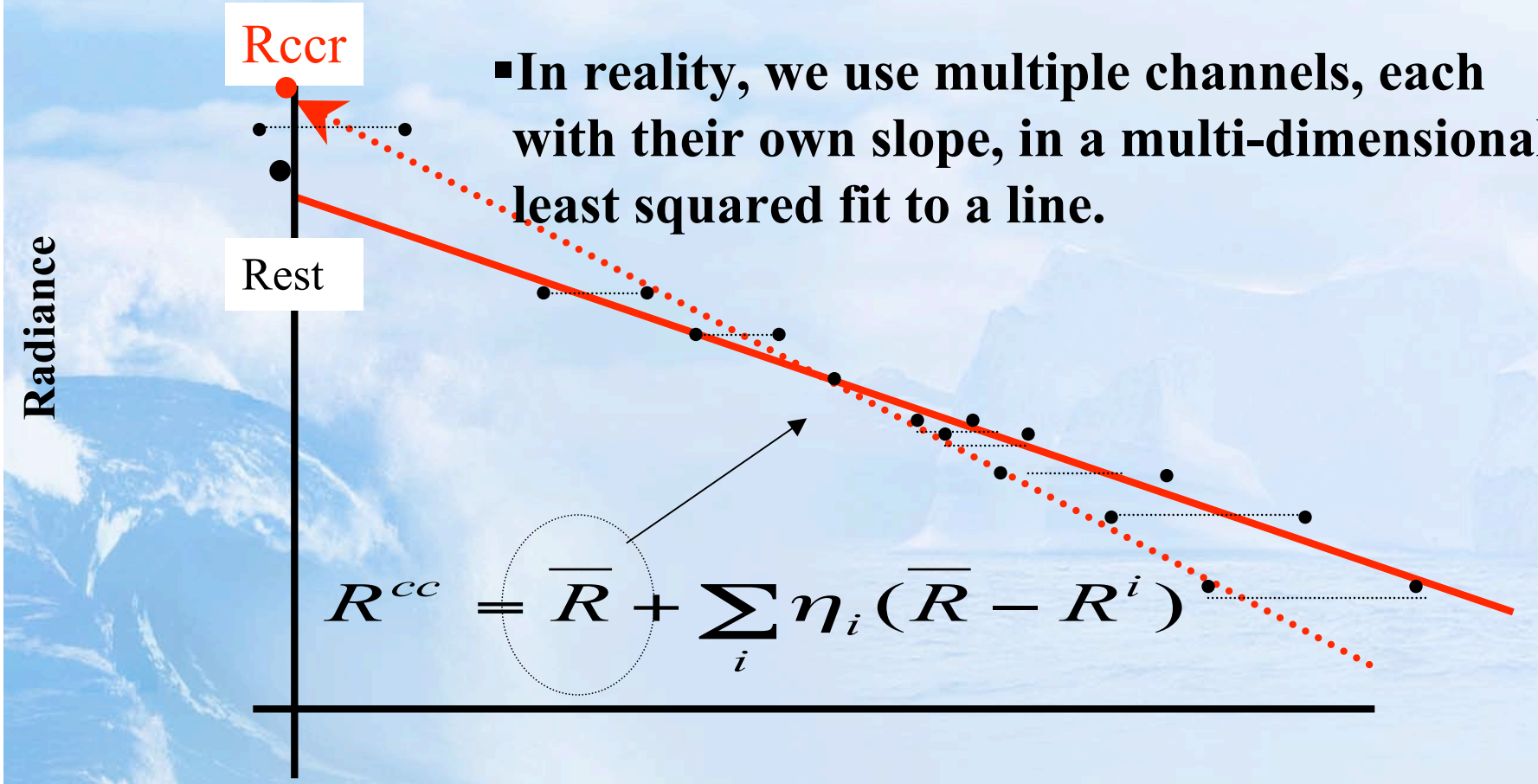
G401, 2002/09/06, v5, |Lat| ≤ 60



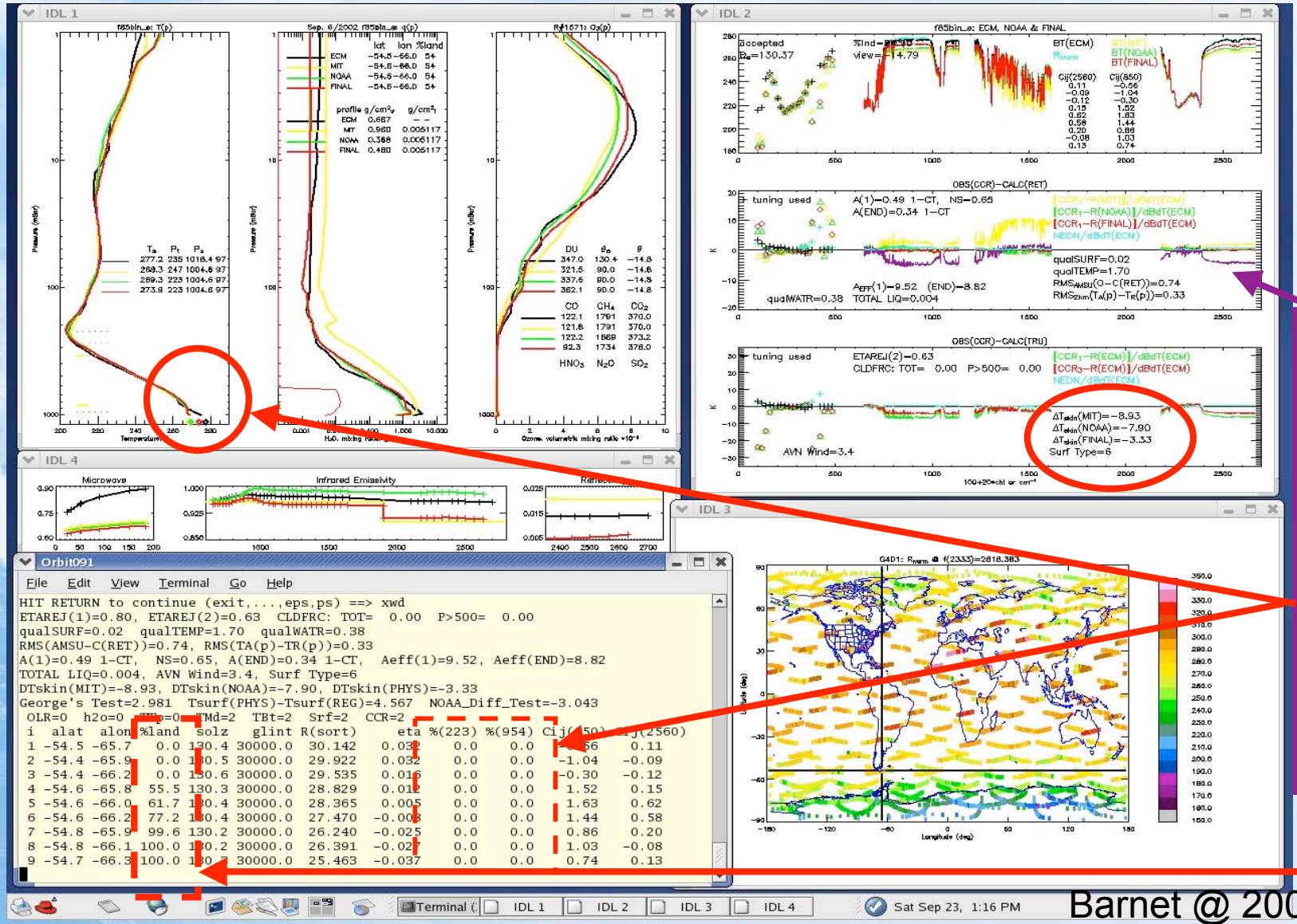
- First noticed by S. Y. Lee
- Rccr-Rwarm should be positive for most cases (except strong inversions) due to clouds in the warmest FOV

Cloud Clearing Method

- **Cloud clearing uses observations to fit a line to the estimate of clear radiance**
- **In reality, we use multiple channels, each with their own slope, in a multi-dimensional least squared fit to a line.**



Example1 of a cold CCR bias: Failed CC assumptions, qual_temp_bot ≠ 0

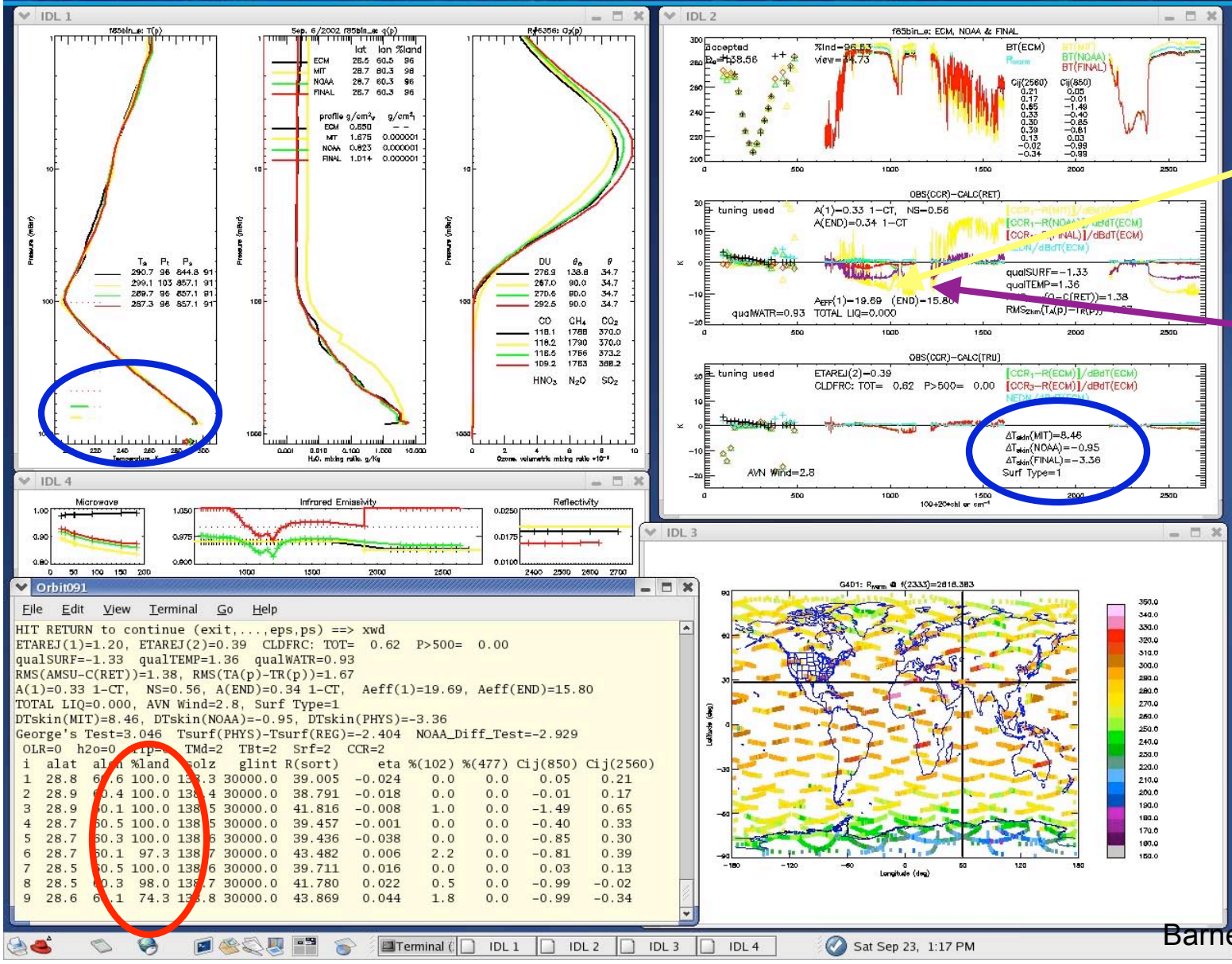


Rccr-Rwarm is really cold

Failed to detect low clouds

coastline

Example2: MIT Starts Out OK, CCR misses clouds



MIT Starts out Warm

4 K cold bias in window region

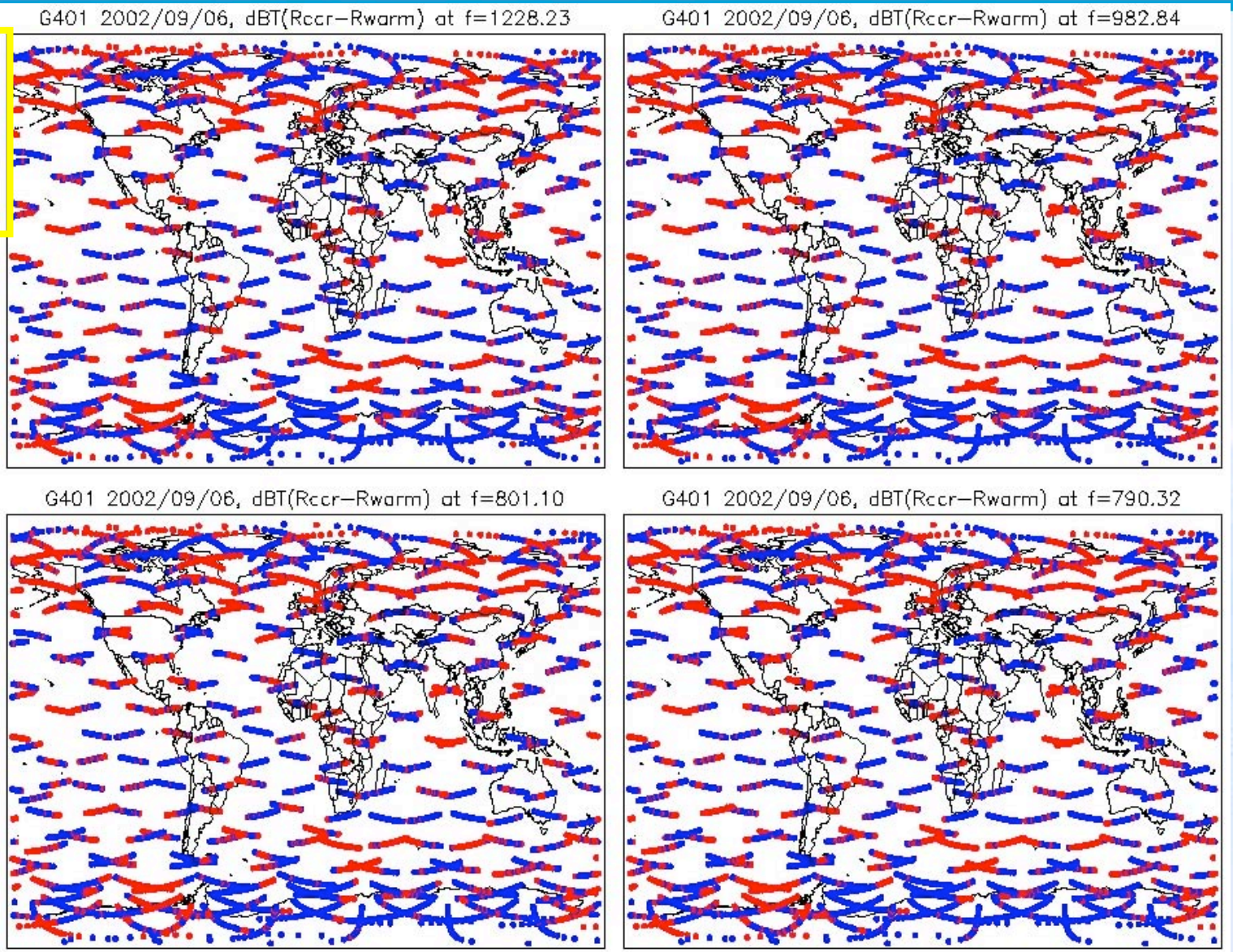
Initially we thought we had clouds, but later we zeroed them out.

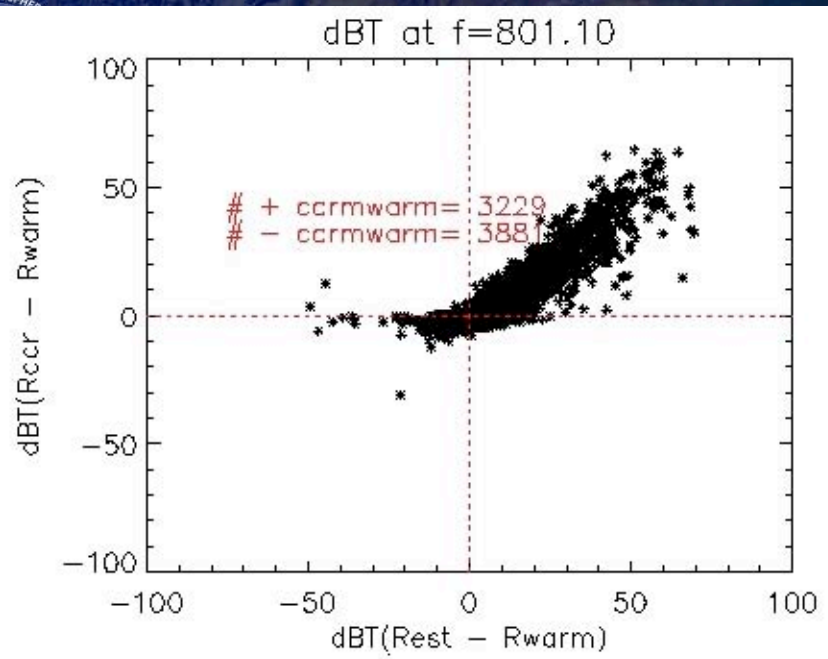
Mixed land & water in scene

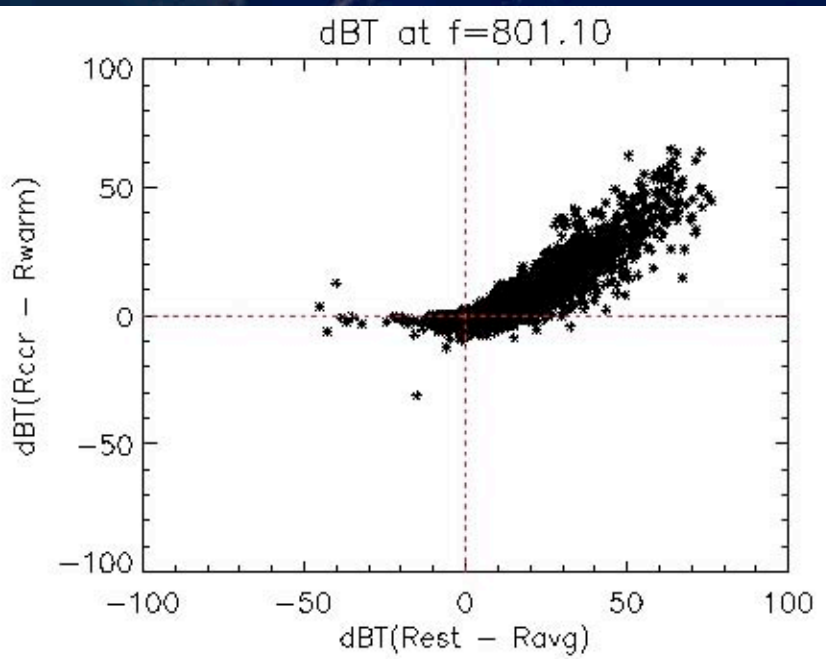
Where ($BT_{ccr} < BT_{warm}$)?

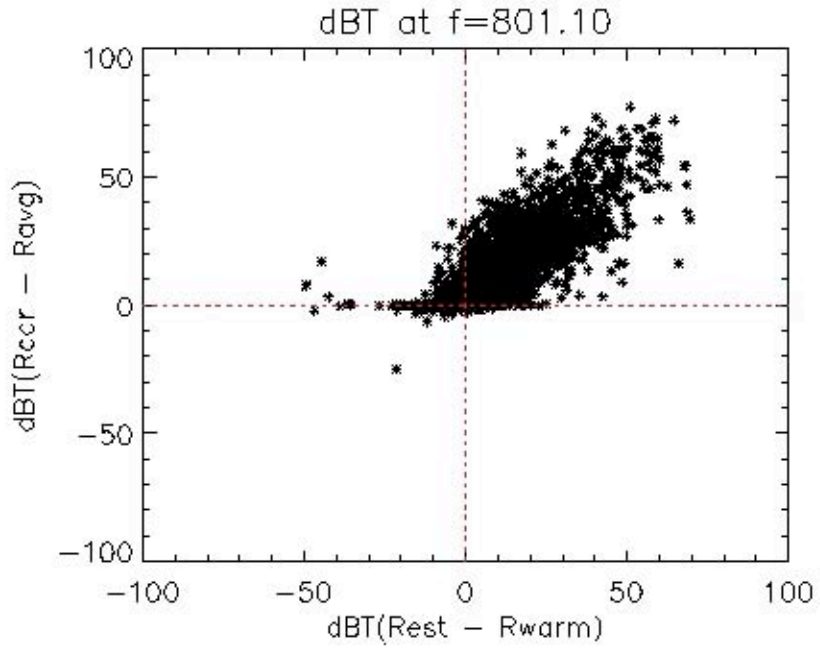
Red:
BTccr ≥ BTwarm

Blue:
BTccr < BTwarm




dBT at f=801.10
# + ccrmwarm= 3229
# - ccrmwarm= 3881
dBT(Rccr - Rwarm)
dBT(Rest - Rwarm)
100
50
0
−50
−100


dBT at f=801.10
dBT(Rccr - Rwarm)
dBT(Rest - Ravg)
100
50
0
−50
−100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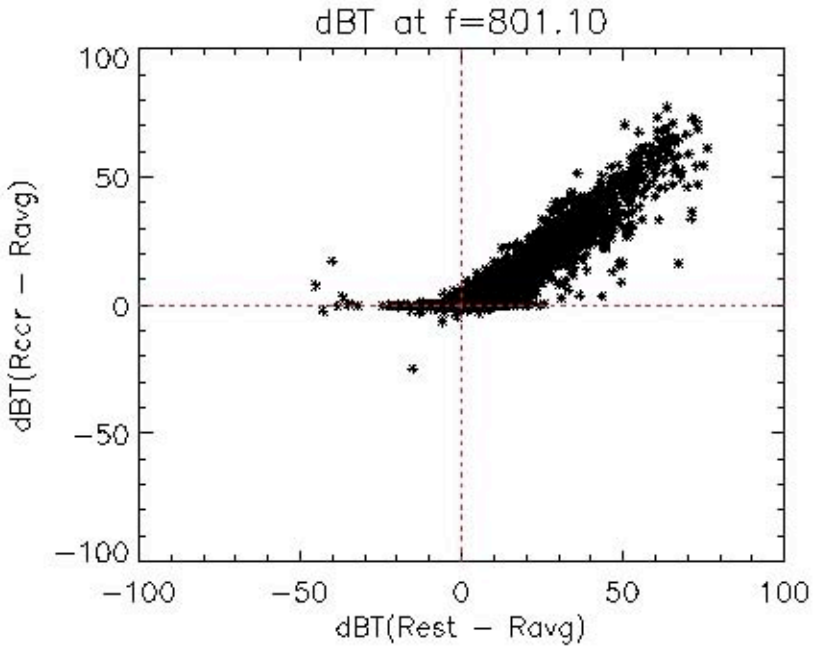
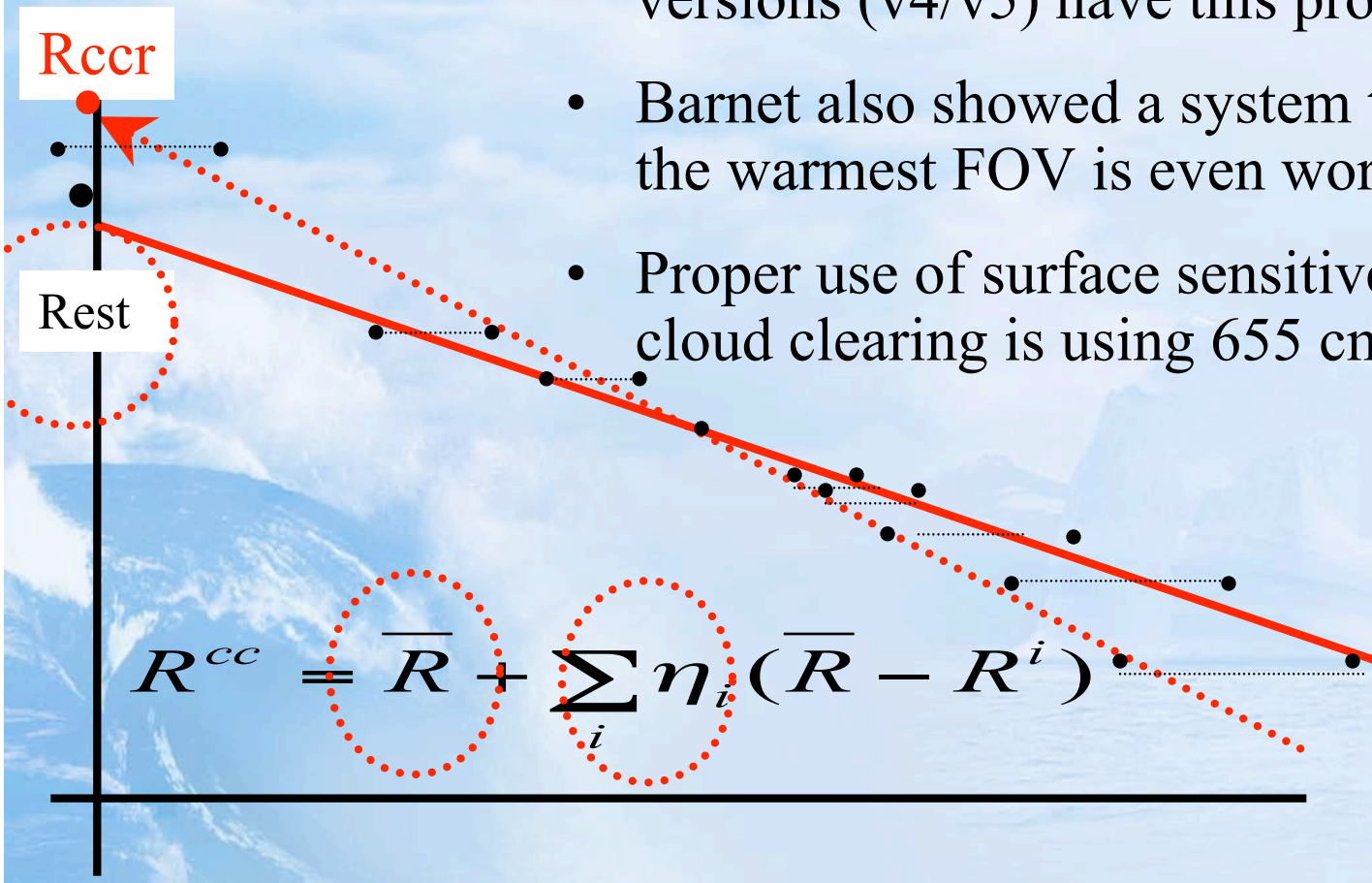

dBT at f=801.10
dBT(Rccr - Ravg)
dBT(Rest - Ravg)
100
50
0
−50
−100

What can we do?

- 2006.09 ASTM Chris Barnet showed all versions (v4/v5) have this problem
- Barnet also showed a system that pivots off of the warmest FOV is even worse.
- Proper use of surface sensitive channels (In v5, cloud clearing is using 655 cm^{-1} ~ 811 cm^{-1})



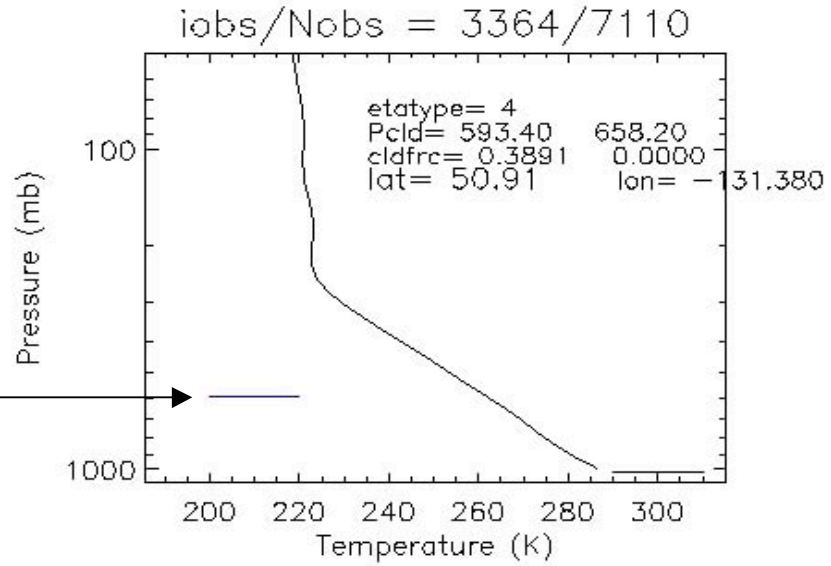
Experiment: Added 4 channels: 820.83, 917.31, 937.91, 979.13

NOTE: In V5, we kicked out these channels over land

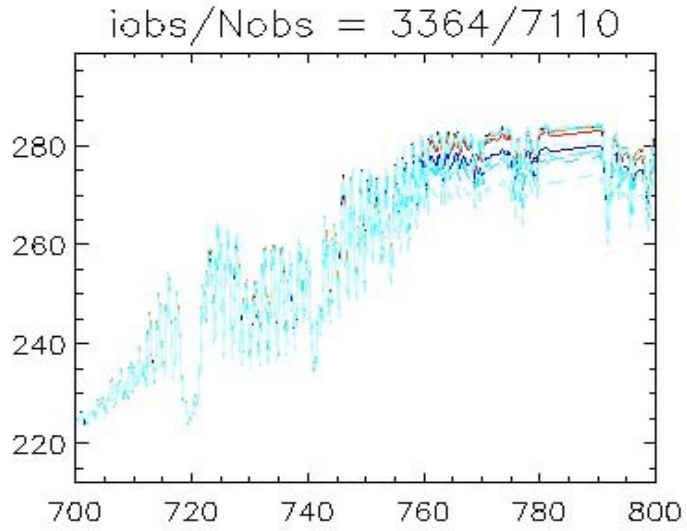
Barnet @ 2006.09 ASTM

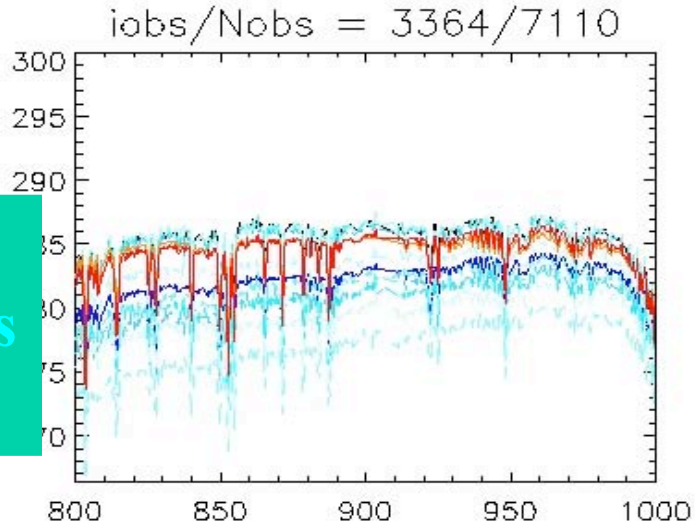
Results

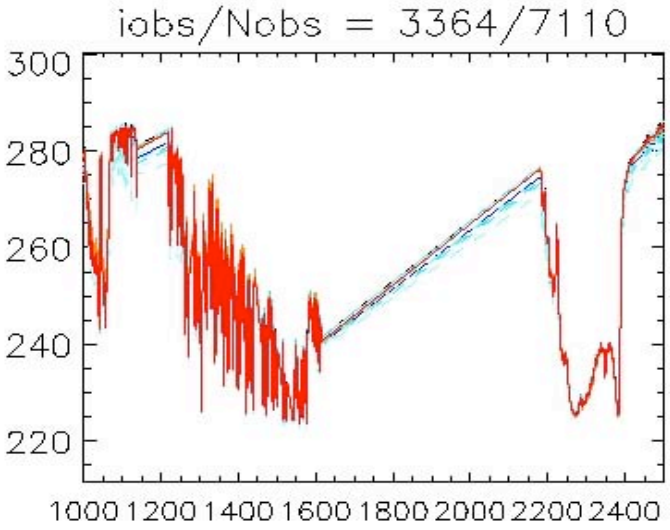
V5 Temperature Profile and Radiances from Rccr and 9 cloudy FOVs



Pcld

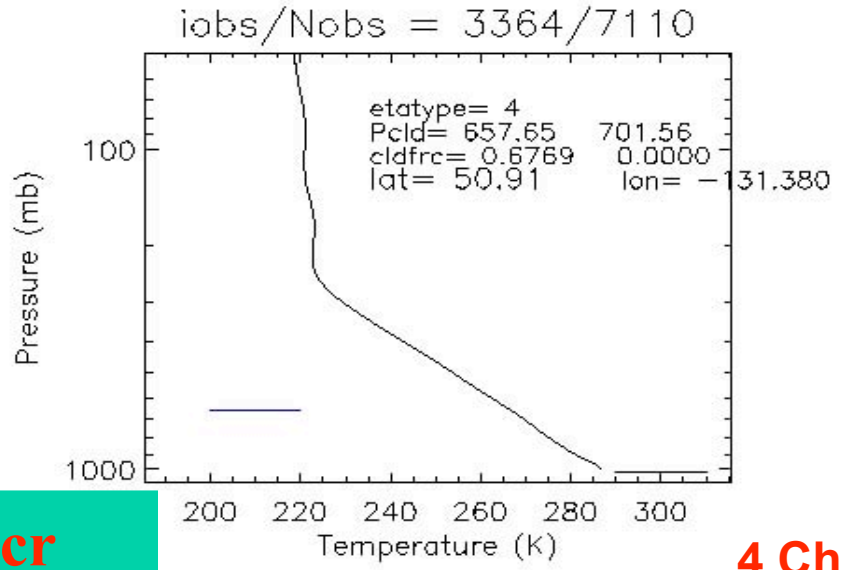


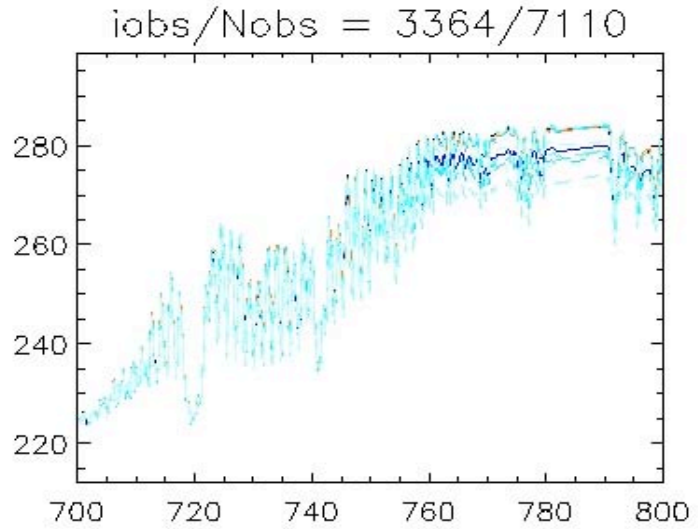




--- Rccr
--- 9 FOVs
--- <R>

V5 + 4 Chls Temperature Profile and Radiances from Rccr and 9 cloudy FOVs





--- Rccr
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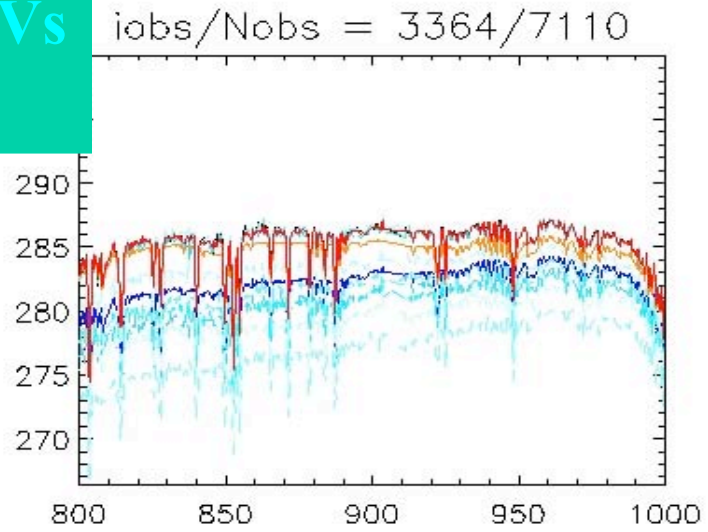
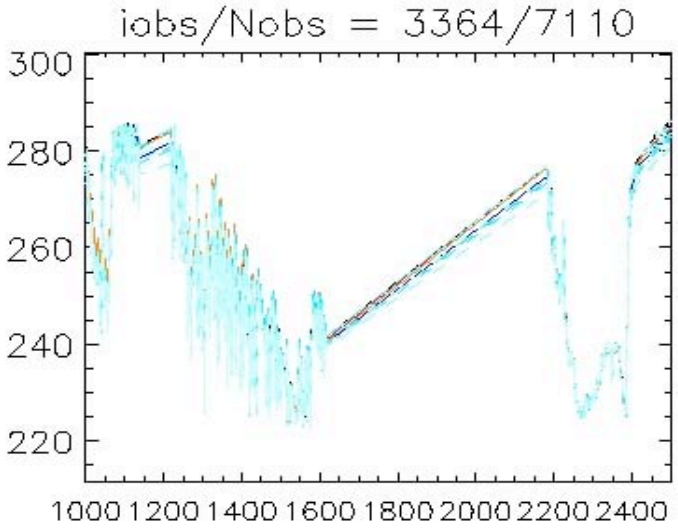
4 Chls: 820.83, 917.31, 937.91, 979.13

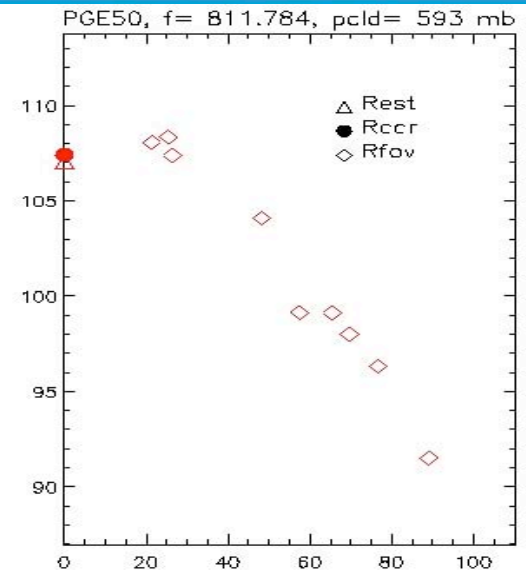


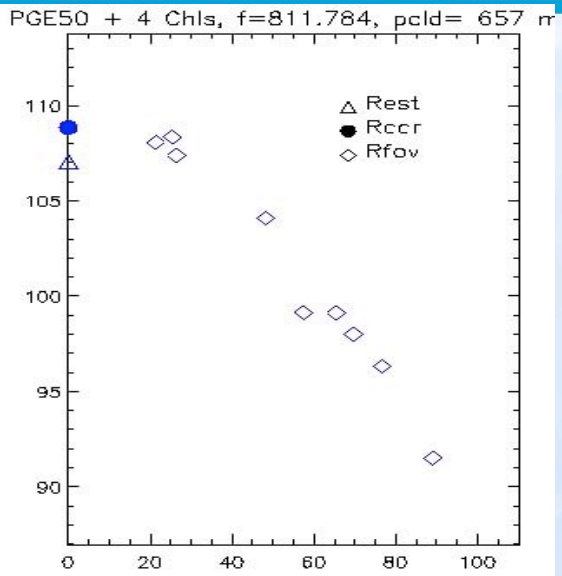


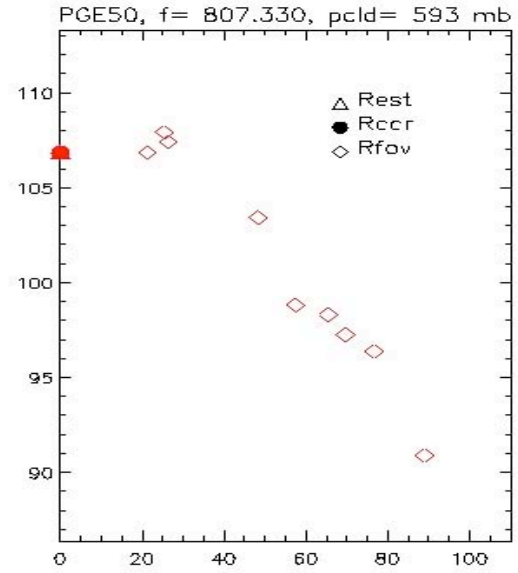
9 FOVs vs. Rccr, Rest

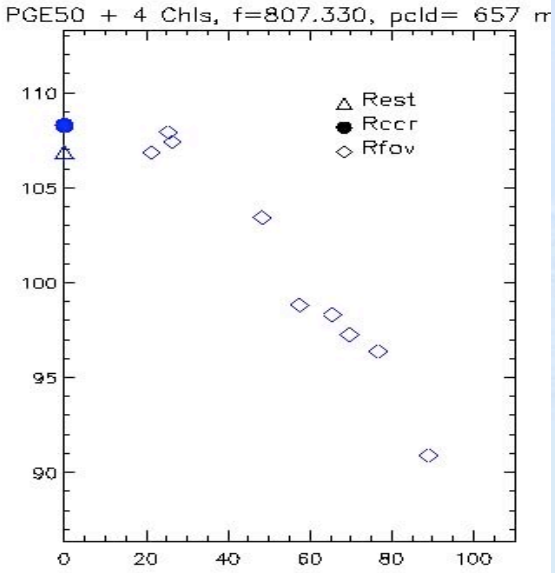
V5

Lat=50.91
Lon = -131.38
Ocean





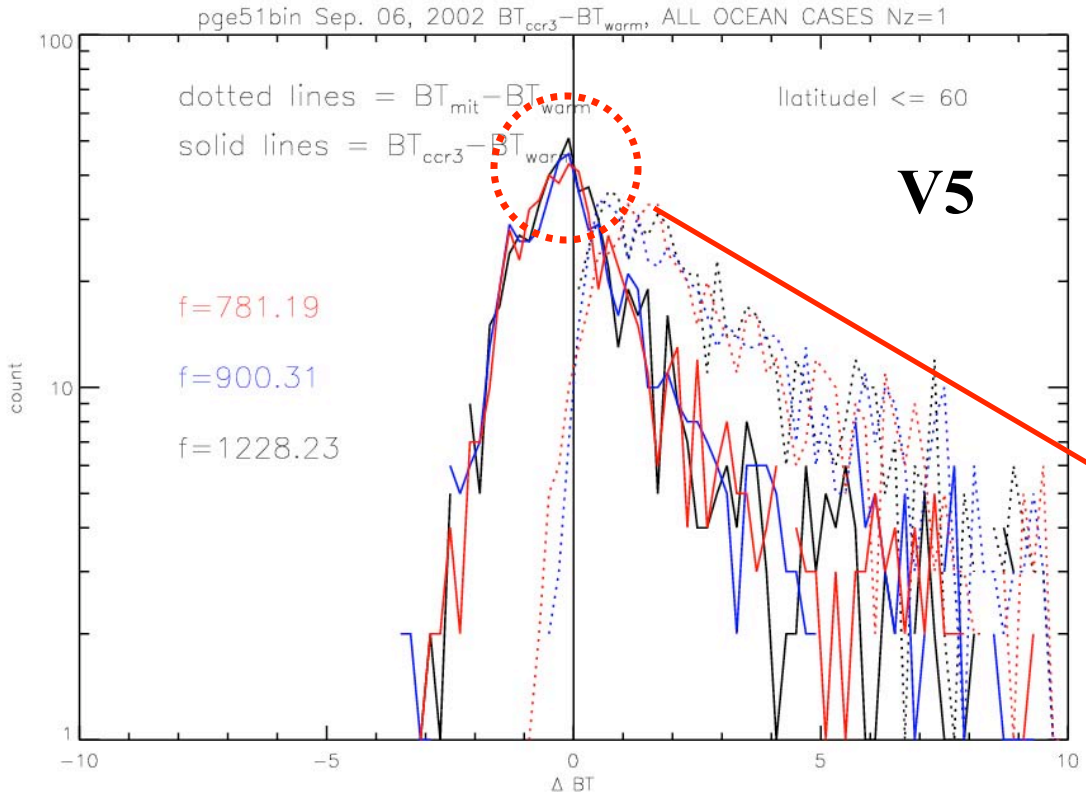


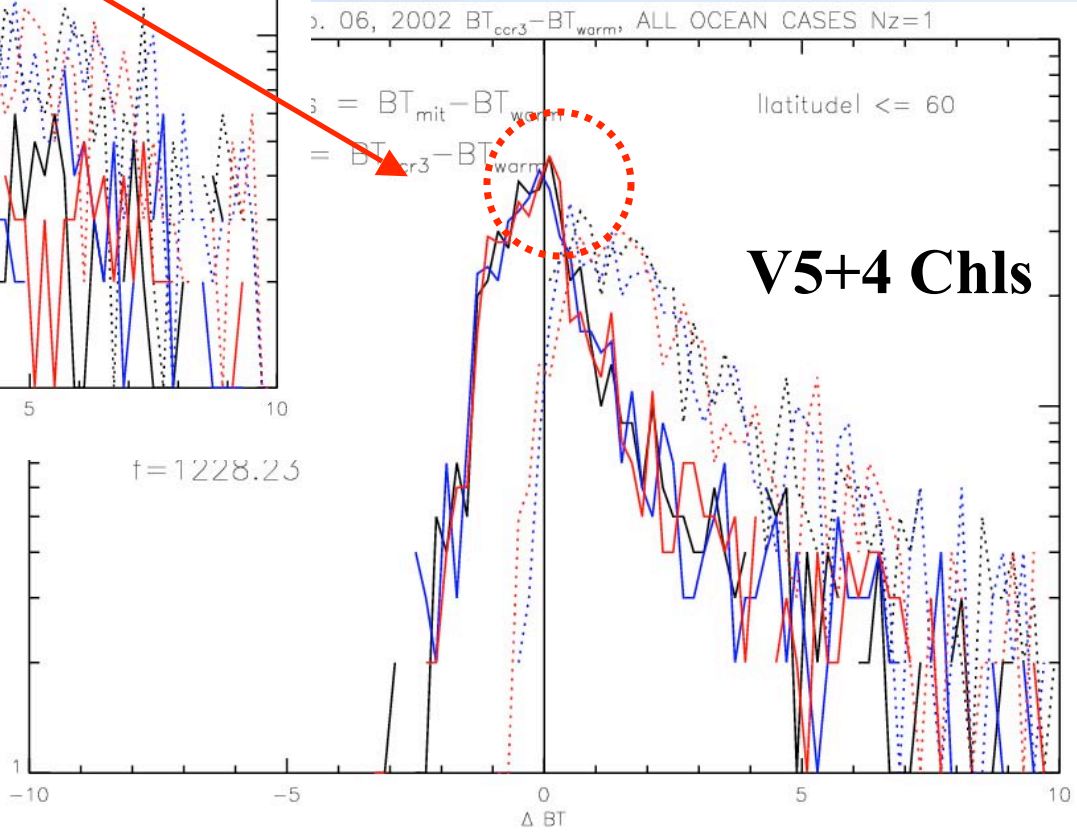


V5 + 4 Chls

- **Cloud top pressure is moving towards lower atmosphere**
- **Cloud fractions in 9 FOVs also changed**
- **If Rest starts out really cold, Rccr will be colder than Rwarm (constraint on Rest-<R>)**

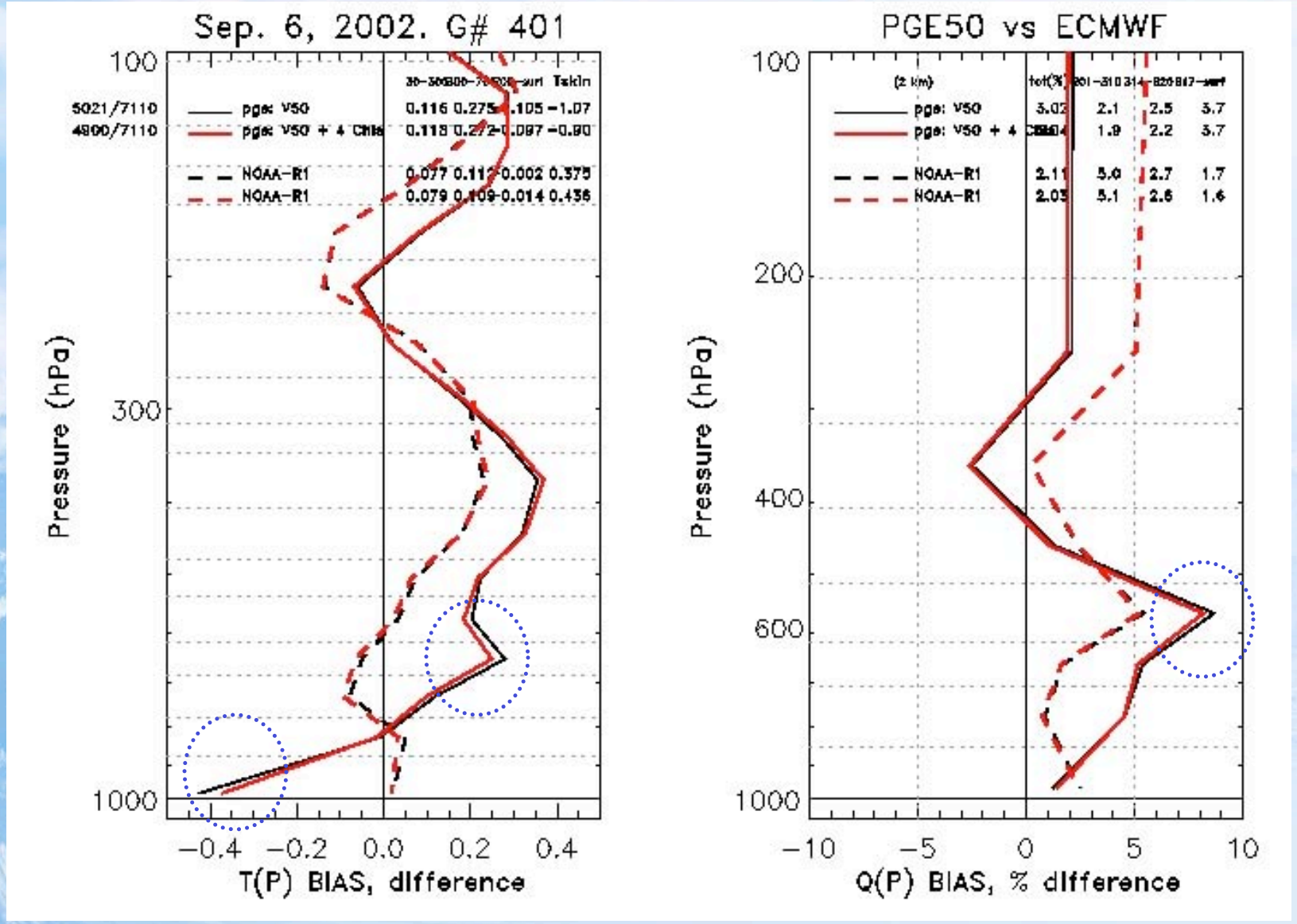
All Ocean Cases



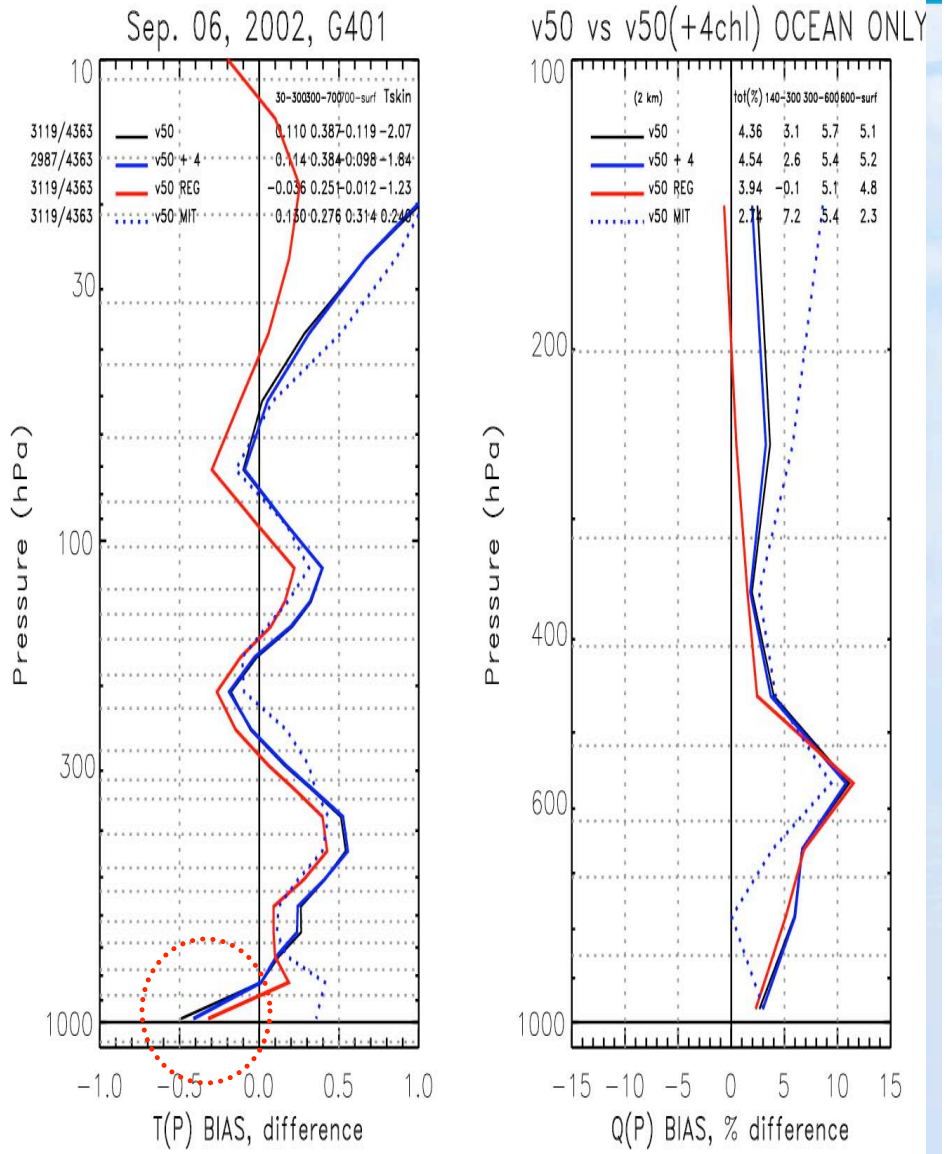


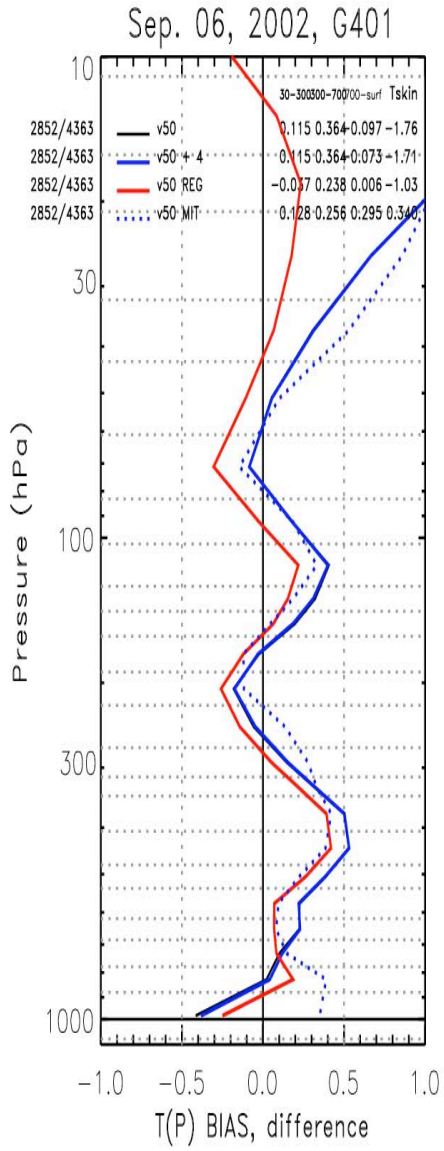
BT$_{mit}$ = BT$_{cloudy\ regression}$

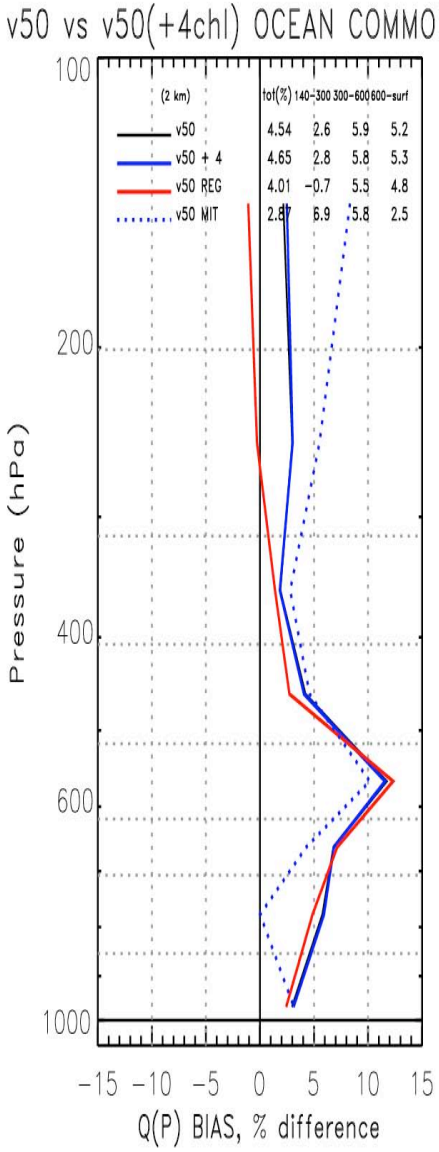
T, Q BIAS (Ret-ECMWF) for G401



T, Q BIAS for Ocean only and a Common Data Set of Ocean Cases

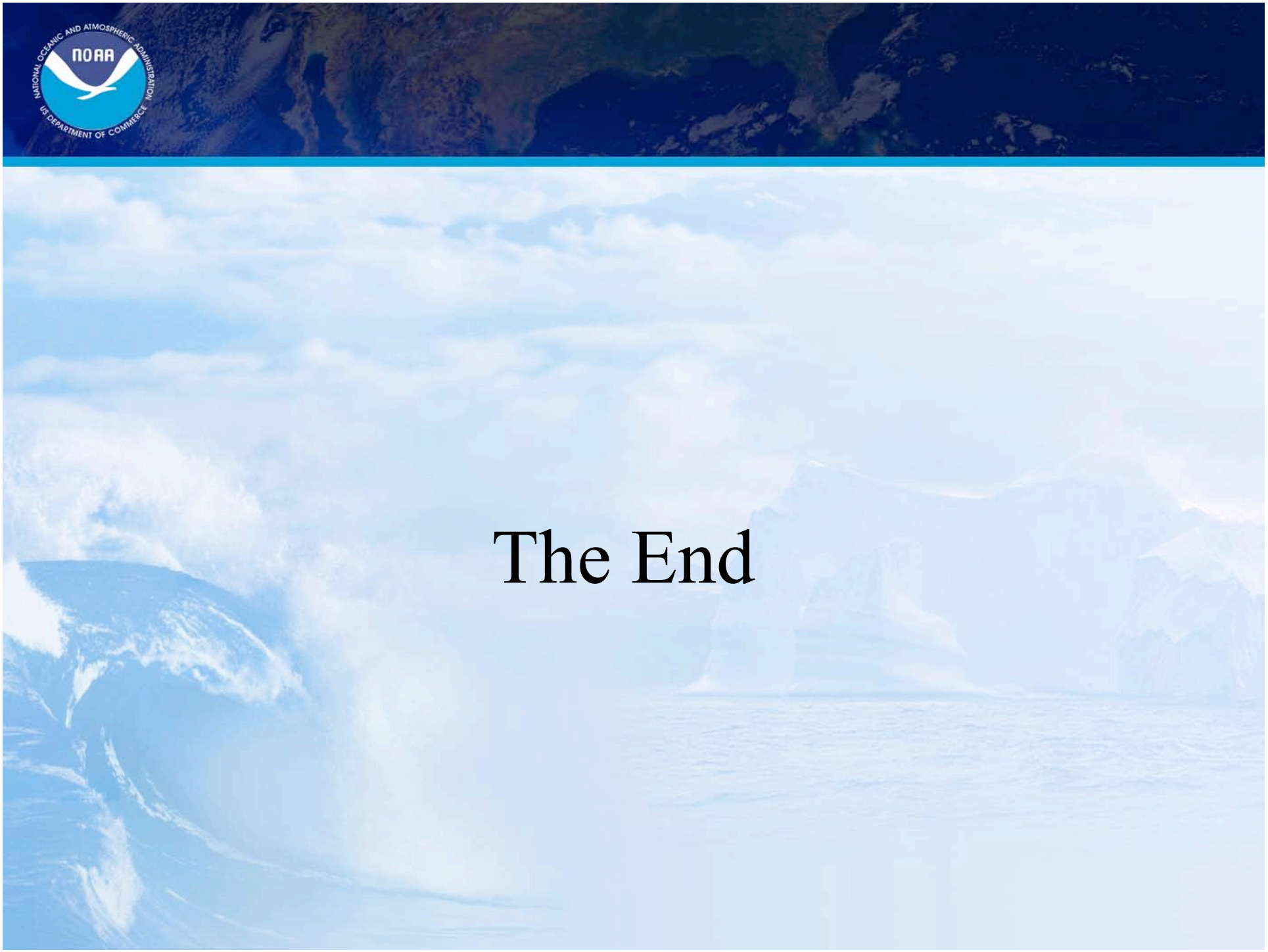




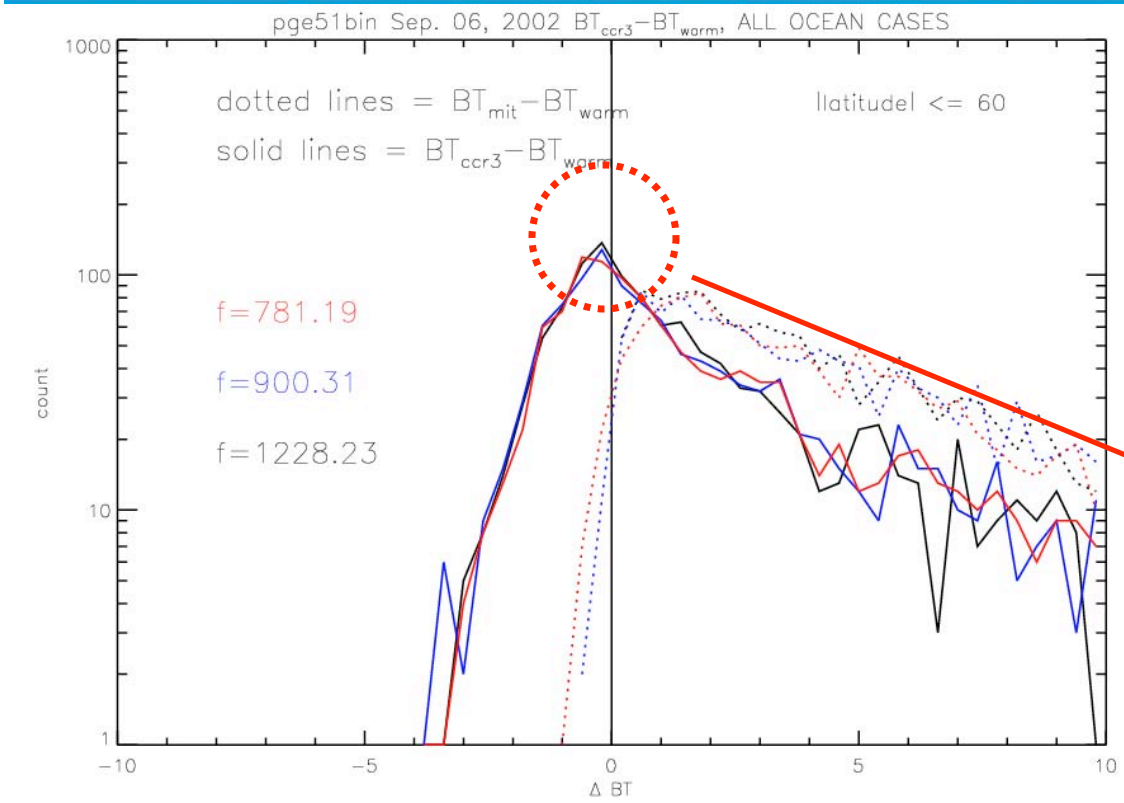


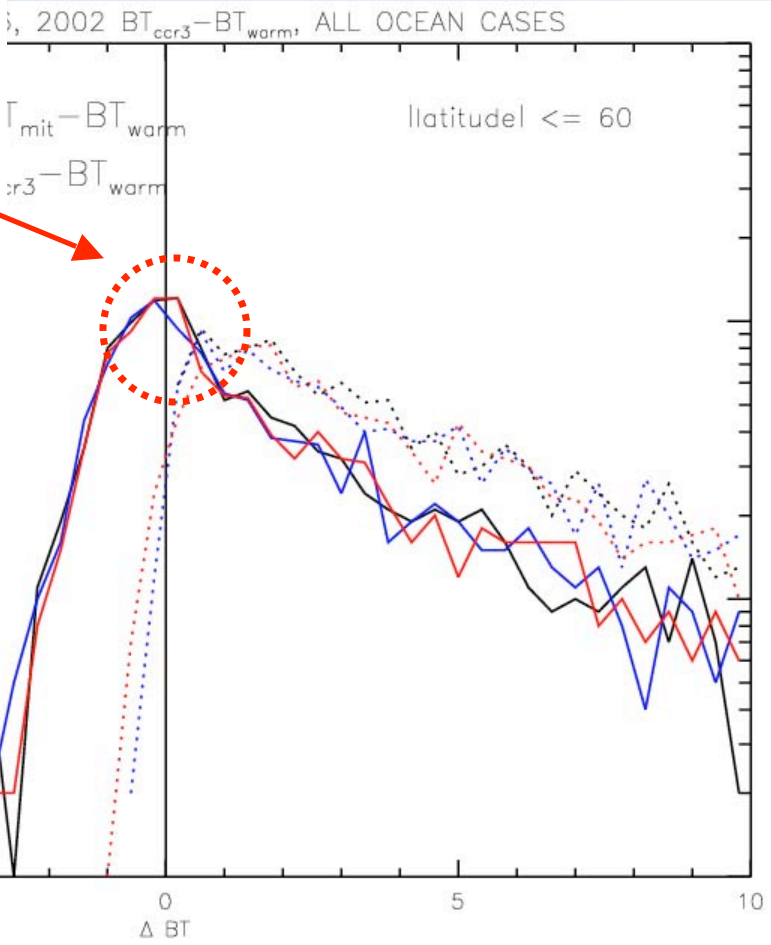
Summary/Future Work at NOAA (Recommendation for V6)

- Cold biases in cloud clearing radiances is coming from cloud contaminated Rest . This can be mitigated by
  - Consider window region channels
  - Proper use of surface sensitive channels (land & ocean)
- Might want to consider an experiment with a simultaneous solution of η and surface skin temperature adjustment
  - Currently we weight the fit by surface sensitivity, so that surface channels have less impact.
  - If we solved for a ΔT_{skin}, then η would be less sensitive to initial cloud contamination.
- Contamination relates to cloud types?
  - Need to compare with other data measurement (e.g, CloudSat/CALIPSO)


The End

All Ocean Cases





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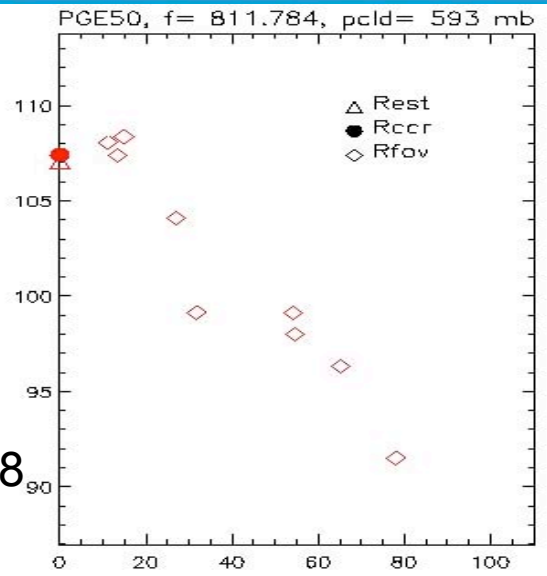
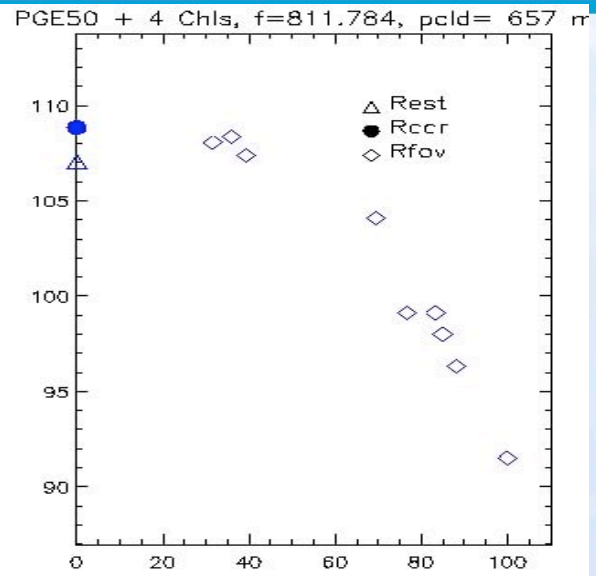
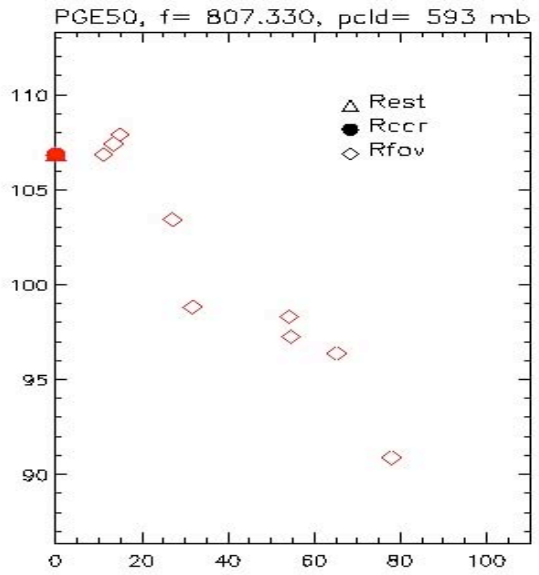
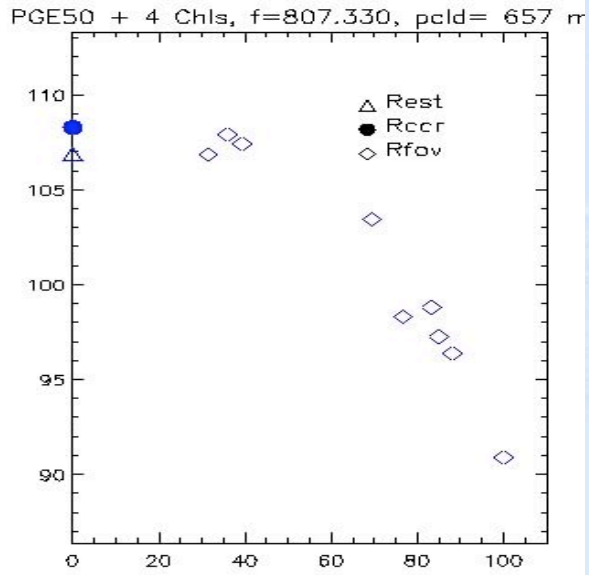




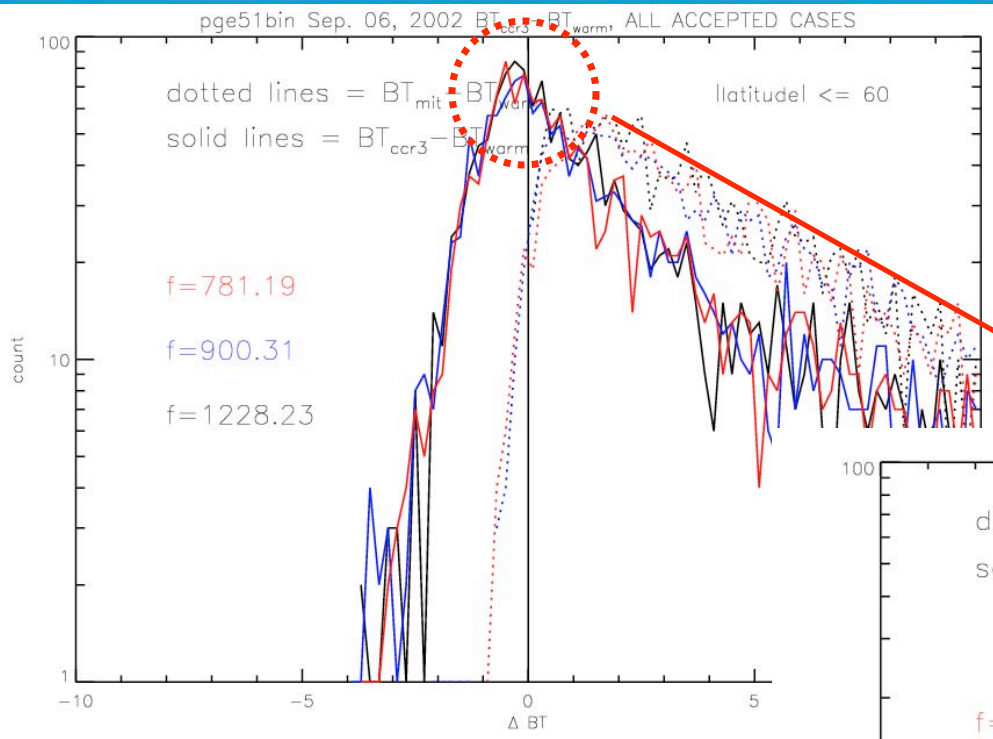




V5 + 4 Chls

- **Cloud top pressure is moving towards lower atmosphere**
- **Cloud fractions in 9 FOVs also changed**
- **If Rest starts out really cold, Rccr will be colder than Rwarm (constraint on Rest-<R>)**

All Accepted Cases



V5

V5 + 4 Chls